

Eve O'Sullivan

Subject: Dumping at Sea Permit Application – Ref: S0034-01 Kinsale Head Gas Field (KEL Response Query #6)
Attachments: EPA Letter 14 10 2022 Response - Query 6 - KH.pdf

From: Corcoran, Laura <LCorcoran@kinsale-energy.ie>
Sent: Friday 14 October 2022 09:42
To: Licensing Staff <licensing@epa.ie>
Cc: Murray, Mike <MVMurray@kinsale-energy.ie>
Subject: Dumping at Sea Permit Application – Ref: S0034-01 Kinsale Head Gas Field (KEL Response Query #6)

Dear Sir/Madam,

We refer to EPA letter dated 2nd September 2022 in relation to Application for a Dumping at Sea Permit, Reg. No S0034-01.

Please find attached responses to Query #6.

I would appreciate if you could confirm receipt of this email.

Regards,
Laura Corcoran

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Environmental Licensing Programme
Office of Environmental Sustainability
Environmental Protection Agency
PO Box 3000,
Johnstown Castle Estate,
Co. Wexford.

Date: 14th October 2022

File: Gov't/EPA

**Re: Kinsale Area Decommissioning Project – Kinsale Head Gas Field – Dumping at Sea Permit
Application – Ref: S0034-01 Kinsale Head Gas Field**

We refer to EPA letter dated 2nd September 2022 in relation to the above application. Please find below and attached response to query 6 of the queries raised:

6. *Provide a degradation assessment for the pipelines and umbilicals, with details on the degradation rates and the structural state of the pipelines and umbilicals over the long-term.*

Please refer to Attachment 1: XODUS Document -

- A-303733-S00-K-REPT-001 A02 - Pipelines and Umbilicals Degradation Study

The additional information supplied in this response does not have any implications for the Appropriate Assessment screening previously prepared for the Kinsale Area Decommissioning Project and those addenda provided as part of Applications 2 and 3. This is because the approach to decommissioning has not changed, the additional information does not result in new pathways of effects for qualifying interests which would result in a likely significant effect, and the assessment and conclusions of the screening, therefore, remain unchanged.

The additional information supplied in this response does not have any implications for the summary of activities in the Application Form previously submitted.

If you have any queries in relation to the above, please contact the undersigned.

Yours sincerely,



M.V. Murray
Head of Engineering & Projects
PSE Kinsale Energy Limited



Kinsale Energy

Kinsale Area Decommissioning Study Pipelines and Umbilicals Degradation Report

ASSIGNMENT A303733-S00
DOCUMENT A-303733-S00-K-REPT-001



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1 INTRODUCTION

1.1 Field Overview

Kinsale Energy Limited operate the Kinsale Area fields, consisting of the Kinsale Head Gas Field, Southwest Kinsale Gas Field, Seven Heads Gas Field and the Ballycotton Gas Field, which are all located approximately 60 km offshore to the south west of Cork, Ireland. Some of these facilities have been in operation since 1977. Kinsale Energy is currently decommissioning the fields.

The Kinsale Head facilities consisted of two offshore platforms; Kinsale Alpha (KA) and Kinsale Bravo (KB) and four subsea drill centres; South West Kinsale (SWK), Western Drill Centre (WDC), Greensand and Ballycotton. The subsea drill centres were tied back to the KB platform with subsea pipelines and umbilicals. The platforms, 5 km apart, were linked by a 24-in and a 12-in pipeline. Gas was exported to the onshore terminal at Inch through a 24-in x 53km long pipeline.

Ballycotton and Greensand production were commingled on the KB platform and routed to KA through the 24-in pipeline. Gas from South West Kinsale was routed from KB to KA separately through the 12-in pipeline.

No gas conditioning was taking place on KB. All of the produced gas was passed through inlet separators, compression trains and a glycol dehydration train on KA prior to export to the shore terminal through the 24-in export pipeline.

The SWK facilities were used as a seasonal gas storage. The SWK pipelines were used for gas injection in the summer months and gas withdrawal in the winter months. production and injection as part of gas storage operations. From 2001 to September 2016 the 24-in pipeline to shore also conveyed dry gas from the onshore gas network for storage in the SWK field when operating in injection mode during summer months.

Gas storage in the SWK field ceased in September 2016. The 12-in SWK lines operated then in full time wet gas operation until Cessation of Production (CoP) in July 2020.

Seven Heads is a separate development, 30km south west of the KB platform. The development consisted of five subsea wells tied back to a central manifold with 8-in flowlines. The production was routed from the manifold through an 18-in pipeline to the KA platform where it was then commingled and processed with KH production.

A layout of the Kinsale Area facilities is shown in Figure 1.1.

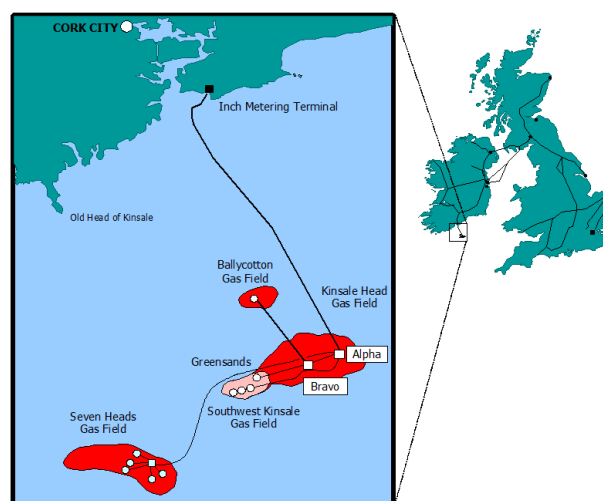


Figure 1-1 Kinsale Area and Seven Heads Field Locations



1.1.1 Kinsale Head – Pipelines and Umbilicals

The Kinsale Head (KH) pipelines are now shut-in, displaced with water and disconnected. Ends are left open to seawater.

Subsea controls were supplied through four main umbilicals from the Kinsale platforms.

Details of the KH pipelines and umbilicals are provided in Appendix A.1, Table A.1 1, Table A.1 2, Table A.1 3 and Table A.1 4.

1.1.2 Seven Heads – Pipelines and Umbilicals

The Seven Heads (7H) pipelines are now shut-in, displaced with water and disconnected. Ends are left open to seawater.

Controls are provided from four in-field well umbilicals at the Seven Heads field.

Details of the Seven Heads pipelines and umbilicals are provided in Appendix A.2, Table A.2 1, Table A.2 2 and Table A.2 3.

1.2 Purpose

This report provides an assessment of the likely degradation rates applicable to the Kinsale Area pipeline and umbilical infrastructure that will be decommissioned *in situ* in response to clarification sought by the Environmental Protection Agency (EPA). The clarification relates to the EPA's review of Kinsale Energy's applications for a Dumping at Sea Permit, Reg No S0034-01 and S0035-01.

1.3 Abbreviations

Ag	Silver
AgCl	Silver chloride
BC	Ballycotton
C	Centigrade (degrees)
C ₃ A	Tricalcium Aluminate
CoP	Cessation of Production
CP	Cathodic Protection
CTE	Coal Tar Epoxy
CWC	Concrete Weight Coat
DNV	Det Norske Veritas
ECHA	European Chemicals Agency
EPA	Environment Protection Agency
FBE	Fusion Bonded Epoxy
in	Inch
KA	Kinsale Alpha (platform)
KB	Kinsale Bravo (platform)
KH	Kinsale Head
km	Kilometre
LPP	Layer Polypropylene



m	Metre
mm	Millimetre
RBI	Risk Based Inspection
SWK	Southwest Kinsale
UV	Ultra-Violet
WDC	Western Drill Centre



2 MATERIALS DEGRADATION OVERVIEW

2.1 Environment

Section 4.0 of the Environmental Impact Assessment for the Kinsale Decommissioning project (Kinsale Energy, 2018) describes the local environment as having water depths extend from the intertidal area at the main export pipeline landfall at Powerhead Bay, to approximately 90m across the Kinsale Head, Southwest Kinsale, Ballycotton areas and to 100m at the Seven Heads field. Surface water temperatures range from 8-10°C in winter to 15-16°C in summer, while bottom temperatures show less variation and remain at around 8-10°C throughout the year. Sunlight hours around southern Ireland ranges from around 50 hours per months in December with May having the maximum at 188 hours per month. Solar irradiance at the sea surface in the Kinsale field area is expected to be low for much of the year due to the limited hours of sun light, and the angle of declination to the sun (solar irradiance) is maximum when the sun is directly overhead making an angle of 90 degrees to the Earth surface thus the time of year and the time of day can greatly affect the amount of solar irradiance at latitudes north of the tropics. The atmosphere screens out much of the UV light below 290 nm from the sunlight before it reaches the earth's surface thus limiting the amount of UV light that is available to cause a chemical reaction significantly. Whilst light can penetrate the water column up to 200 m, it is rapidly attenuated by depth (Heidi M. Sosik & Sönke Johnsen, 2004, Sigman, D. M. & Hain, M. P, 2012) such that by 10 m only around 16% of the energy in the electromagnetic spectrum that falls on the surface remains and by 100 m only 1% of this energy remains with the wavelengths available centred on blue light with little to no UV light remaining in the spectrum at these depths.

The seafloor is generally flat in the area encompassing the Kinsale Area fields with gentle slopes across the region. With a seabed comprised of both gravelly sands (with megaripples of up to 0.3m height and 1.5m wavelength) and muddy sand. At water depths of 90-100 m, the megaripples are indicative of a high energy environment. The Celtic Sea is particularly susceptible to rough seas due to strong to gale force south-westerly winds. Swell distributions are dominated by swells from a south-west and west direction throughout the year, with mean significant wave heights varying between 1-1.5 m in summer to 3 m in winter.

2.2 Pipelines

2.2.1 Corrosion of Steel in Seawater

The pipelines are either surface laid with some degree of burial or trenched and rock dumped (see Tables A.1 1 and A.2 1 for details). The corrosive environment consists of seawater and seabed mud saturated with seawater. The primary corrosive agent is oxygen, which diffuses to the pipe surface to be reduced to form hydroxyl ions.

In the Celtic Sea, the average seabed temperatures are less than 10°C. Furthermore, the profile of oxygen concentration is fairly uniform and salt content is in the order of 3.5%.

The corrosion of carbon steel in seawater is mainly controlled by the rate of supply of dissolved oxygen to the steel surface. Waves and currents increase the transfer of oxygen to the steel surface and hence increase the corrosion rates. Equally, if the transport of oxygen is impeded by the presence of coatings, corrosion product films, calcareous deposits or marine growth, the net corrosion rate due to oxygen will decrease. Corrosion can proceed by general thinning of the metal or by a more localised effect.

The corrosion in the tidal zone is relatively mild, but high corrosion rates near the top of the submerged zone can be observed. However, this is mainly seen in shallow water, less than 3m deep. In deeper water or where the difference in water level of high and low tides is small, a sharp corrosion increase below low water level does not occur (Zen, 1974).

Under immersed conditions, corrosion rates for unprotected steel range between 0.1 to 0.2 mm/year (Roberge, 1999), gradually decreasing with depth. The value most commonly used as the expected average corrosion rate of steel



continuously immersed in seawater is 0.125 mm/year (LaQue, 1948). However, the average corrosion rates for periods >10 to 20 years and >20 years are 0.07 and 0.05 mm/year, respectively (Uhlig, 2011).

Corrosion can also take the form of pitting which is a very localised attack. Whereas the rate of general corrosion may be low, the rate of metal dissolution in active pits can be high. The pitting attack on bare steel is frequently 0.25-0.38 mm/year (Fink, 1960), but the rate decreases with time. An extended initiation period is usually required before pits become visible. This period can be up to several years, depending on both the metal and the environment.

Low general corrosion rates between 0.02 to 0.05 mm/year can be seen for steel buried in the seabed; however, rates can vary locally at the mudline due to differential concentration cells, scouring, marine growth and sulphate reducing bacteria (SRB) activity. SRB require an anaerobic (oxygen-free) environment such as seabed mud to flourish. Although bacteria growth is restricted within a range of pH and temperatures, when active their effect is a local increase in the corrosion rate of the item attacked. In this situation, corrosion rates can be as high as 0.5 to 2 mm/year.

2.2.2 Pipeline External Protection

The pipelines were designed with an external corrosion protection system consisting of anti-corrosion coating (with and without concrete weight coating) supplemented by sacrificial anode cathodic protection (CP) systems to protect areas of coating defects, damage or breakdown.

The degradation of polymeric coatings is discussed in the umbilicals section below (Section 2.3.2). The pipeline concrete weight coating can decompose due to chemical attacks. The constituents of seawater, in particular, chloride, magnesium and sulphate ions, can react chemically with the constituents of cement concrete leading to deterioration by leaching. The temperature is a factor of the chemical attacks; the higher the temperature, more will be the attack.

Concrete is not 100% impervious. Seawater enters into the pores of concrete and when it reaches the reinforcement then corrosion will occur. When the reinforcement steel corrodes, the resulting rust occupies a greater volume than the steel. This expansion creates tensile stresses in the concrete, which can eventually cause cracking, delamination, and spalling.

Concrete can also be damaged by abrasion by movement of sand and silt on the seabed, or wave action in shallow water.

Nevertheless, the concrete weight coating for pipelines is typically specified with low C3A cement to resist sulphate attacks, low water/cement ratio to make it more impervious, chloride-free admixtures, or adequate cover over the reinforcement to enhance durability. The temperatures at the seabed are low and thus rates of chemical attacks are reduced. The pipeline weight coating is thus expected to last decades if not hundreds of years.

The pipelines are also fitted with zinc or aluminium sacrificial anodes. Carbon steel is protected from corrosion where the steel potential is more negative than -800 mV (vs Ag/AgCl/seawater reference electrode) and will freely corrode when the potential is more positive than -600 mV. Between -600 mV and -800 mV, the steel is under-protected and some corrosion will occur, albeit at a much lower rate than the free corrosion rate.

The latest subsea cathodic protection surveys indicate that the pipelines are adequately protected (Kinsale Energy, 2019), with sighted pipeline anodes at worst 50% depleted. There is thus enough anode mass left on the pipelines to continue protecting them against external corrosion for a number of years, even if pipeline coatings are degrading.

The reduction in cathodic current density due to the application of an electrically insulating coating is described in CP design by the use of coating breakdown factors. The more recent versions of CP design codes contain significantly reduced breakdown factors compared with older versions. This is in part due to reduced conservatism, but also due to coating application processes improving. This leads to much lower anode mass requirements than were specified when the pipelines were designed. As an example, the anode mass requirement for the 12-in SWK pipeline to KB was about 1,450 kg of aluminium anodes to ensure protection for 20 years. The same pipeline requires only about 170 kg of aluminium anodes when designed with the latest version of DNV-RP-F103 (DNV, 2021).



The pipeline CP is thus considered over-designed, and external protection by the CP system and then by the external coating is expected to last for several decades before steel starts to largely corrode externally.

Internal corrosion of the pipelines due to free flooding seawater through the open ends is thus a more likely cause of degradation than external corrosion.

2.3 Umbilicals

2.3.1 Plastic Materials

The hoses, textile tapes, textile ropes and rovings of the umbilical will be composed of different plastics, most likely polyethylene, polypropylene and polyamide.

Plastic is a generic term for a wide range of polymers made from one or more monomers and a range of added excipients which modify the physical properties of the final polymeric plastic. Plastics are present in many items encountered in daily life that exploit the plastics' various properties such as ease of moulding, flexibility, ease of colouration, durability and cheapness. The versatility of plastic material extends to the oil and gas industry where it can be found in many applications. Flexible pipes, umbilicals and cables are composed of different types of plastic and other materials combined to exploit the properties of each fully to deliver bespoke solutions for the harsh undersea environment in which these components are used. The stability and persistence of plastics in the environment vary between types of plastic, and those selected for use in items that need to maintain the containment of hydrocarbons and other chemicals from the environment are selected to some extent for their stability and resistance to degradation.

The degradation of plastic typically begins at the macroscopic scale with chipping and cracking because of embrittlement, which is brought about because of thermal cycling, exposure to ultraviolet light, stress (e.g. flexing, twisting) and ablation with small particles of sand. Ablation refers to the removal of material from the surface of an object by vaporization, chipping, erosion, or related processes (Faghri and Zhang, 2006). In deep water thermal cycling and UV light have less influence on degradation than on land and for plastic that is buried in the seabed stress and ablation are also not a concern. Whereas for pipelines on the seabed or in the water column, stress and ablation are potentially of greater concern.

2.3.2 Degradation of plastics

Although there are many studies on the degradation of plastic in the laboratory by polymer scientists there are only limited studies on the environmental degradation of plastic in the marine and coastal environment (Papatheodorou & Karapanagioti, 2021). Therefore, the probable impact is very complicated to estimate. Worst-case scenarios have been considered.

The degradation process for plastic results from a combination of abiotic (physical/physico-chemical) and biotic (biodegradation) processes. These in turn depend on the presence of oxygen, temperature cycling (or high temperatures), UV radiation, physical impact and microorganisms (bacteria or fungi).

At the bottom of the sea where the Kinsale fields and most subsea infrastructure containing plastic are located (> 90 m deep), there is little UV radiation, and the temperature is relatively stable. The umbilicals are predominantly buried or covered and therefore the subsea environment is relatively benign for plastic with respect to these breakdown mechanisms.

Physico-chemical degradation of subsea plastic will involve possible ionizing radiation (gamma or X-rays), creep, fatigue, environmental stress cracking and ablation (weathering). Typically, chemical degradation of plastics involves oxidation (requiring O₂), which can be accelerated by microbial action. While all biomaterials, including plastics, will invariably biodegrade in the marine environment, the rate of this process, even in the benthic sediment, is significantly slower compared to light-induced oxidative degradation of plastics (Andrady, 2011). Many plastics are manufactured



containing antioxidants which prevent oxidative degradation by reacting with free radicals. Free radicals are reactive species created through oxidation (e.g. interaction with UV/ionizing radiation) which can react with the polymer chain causing degradation. Over time all antioxidants contained within the plastic will be consumed leading to an increase in the rate of degradation. Given the seabed is relatively temperature stable and is a low UV light environment this method of degradation is likely to be slow and will take a very long time.

Another physical mechanism that might impact the structures are fishing activity. Bottom trawling is one of the most common fishing methods in the area, consisting of trawl nets that are designed to be towed by a boat along the sea floor. Trawl nets have bobbins or rollers on the ground gear to allow the net to move over the sea floor without snagging and to minimize bottom contact. The impact energy from trawl gear is dependent upon design and trawl speed, but this may be enough to damage exposed subsea infrastructure. It is therefore possible that if exposed umbilicals experience impacts from trawl gear that may lead to cracking and chipping of the plastic and accelerate the degradation of the plastic line. Umbilicals that are buried or covered with rock are protected from this sort of impact.

When broken from the main structure, lighter density polymers like polyethylene and polypropylene are usually buoyant in sea water, while high density polymers like polyethylene may sink. UV radiation may contribute to the buoyant particles being broken down, however in one study when a plastic material was exposed to sunlight while floating in seawater, degradation was severely retarded (Andrady, 2011). Therefore, the most credible pathway for breakdown of residual plastic is weathering via mainly abiotic mechanisms, which over a long timeframe could result in embrittlement and disintegration of the materials into smaller particles.

Biofouling would also slow the degradation process by shielding of any exposed material from scour or other mechanical abrasion. As described in Section 1.1.1, most of the umbilicals are trenched or buried or covered with rock / mattresses. A growing body of literature has focused on the microbial life growing on the surfaces of plastics and are called the "plastisphere," but the general concepts of microbial ecotoxicology have only rarely been integrated (Justine et al., 2019).

Once broken into microplastics microbial degradation and mineralisation of many plastic polymers is a theoretical possibility. However, microbial numbers in the marine environment are low compared to estuarine riverine and terrestrial environments. In addition, the lower temperatures experienced in offshore deep waters, as well as microbes often needing to adapt to utilise a new substrate mean that biodegradation rates are very slow in the ocean even for relatively simple molecules (Arutchevi *et al.*, 2008). Biomass and organic matter do not accumulate in the surface ocean, as it is nearly entirely decomposed back to dissolved chemicals (Sigman, D. M. & Hain, M. P, 2012). This high efficiency of decomposition is because the organisms carrying out the decomposition rely upon it as their sole source of chemical energy and are therefore adapted to this carbon and energy source for survival. For the carbon in plastic polymers to enter this microbially mediated process, would require an organism with a specific metabolic capability to breakdown the polymer chains into simpler molecules. Whilst many plastics may degrade in this manner given favourable conditions rates of degradation in the marine environment are likely to be negligible.

2.3.3 Release and Degradation of other added chemicals

In the subsea infrastructure in the Kinsale fields, other added chemicals can be found combined with the plastics. These include colourants, plasticizers, rubbers, glues and other additives. Some of these compounds are added during plastics manufacture, others during the fabrication of the umbilical, while others may adsorb from the surrounding seawater or the chemicals they transport. The chemicals added to a plastic are chosen depending on the application of the plastic and are used to tune the properties of the plastic before it is formed into the final product.

Colourants fall into two broad categories: pigments and dyes (R. M. Harris, 1999). Pigments are colourants that do not dissolve into the plastic, whereas dyes are colourants that do go into solution. Dyes are used in applications where powerful tinting is needed. Pigments can be divided into inorganic and organic pigments. Inorganic pigments



have superior heat resistance and weathering properties compared to both dyes and organic pigments. Yet, some inorganics are perceived as health hazards (R. Kany *et al.*, 2001). Thus, the industry trend is shifting from the use of inorganic pigments to organic pigments. The pipelines in the Kinsale fields were in use before 2011, therefore, if pigment was used in their production, it is possible that the inorganic ones were used. These colourants are expected to be very persistent, taking a long time to degrade.

The umbilicals, in the Kinsale fields are relatively protected from physical impacts, UV light and thermal cycling. Much of the lines are covered or trenched over large proportion of the free surface, thus protecting the plastic surface from ablation by sand in much of the fields. Thus, the physical processes that would bring about the breakdown of the exposed surface of the lines and the degradation of the polymers is expected to be very slow. The rate of breakdown at Kinsale is likely to be over hundreds of years assuming that there is no significant disturbance to the benthic environment over that time.

Chemicals inside the structure of the umbilicals (plasticizers, colourants, adhesive) could be released as the plastics start to degrade, although in low concentrations.

2.3.4 Metals

The umbilicals contain both steel wire armouring and electrical conductors (most likely copper). These metals will be relatively stable until the integrity of the umbilical begins to break down and seawater is able to reach these metals. Once this has happened then the metals will become corroded and form salts with the cations in the seawater. This corrosion will be relatively rapid once it starts due to the high surface area to volume of the wires but will not commence until the integrity of the outer plastic layers has been compromised in several hundred years.

2.3.5 Bitumen

Bitumen is a substance produced through the distillation of crude oil; It is composed of complex hydrocarbons and contains elements like calcium, iron, sulphur, and hydrogen. Bitumen is known for its waterproofing and adhesive properties. Production occurs through distillation, which removes lighter crude oil components like gasoline and diesel, leaving the heavier bitumen behind. Bitumen contains a wide range of hydrocarbons with varying aqueous solubilities and therefore there is potential for components to leach from the bitumen if exposed to seawater and have an ecotoxic effect. However, at seabed temperatures the bitumen would be solid and exposure to seawater would only occur through cracks in the outer plastic coating of the line, therefore leaching of any components would be highly localised and slow such that no discernible effect is likely to occur. As the exposure of the bitumen is dependent on the degradation of the umbilicals' external plastic layer any degradation of the bitumen and release of chemicals they contain is not expected for hundreds of years.

2.3.6 Chemicals in umbilical hoses

The other chemicals present within the various lines have been assessed separately as part of the Dumping at Sea Application and are not considered further here.



3 KINSALE HEAD

3.1 Pipelines

3.1.1 Pipeline Degradation

To evaluate the time to complete degradation of the KH pipelines, the wall thickness loss up to 2022 has been estimated for each pipeline based on inspection results, where available, and predicted in-service corrosion rates from the RBI assessment (Penspen, 2019).

The 24-in export pipeline and the two inter-field pipelines (24-in and 12-in between KA and KB) were the only pipelines internally inspected during their services. The 24-in export pipeline was last inspected in 2017 while the 12-in and 24-in inter-field pipelines were inspected in 2013 and 2008, respectively. Almost all found internal metal loss features were less than 5% of the nominal wall thickness. Some external corrosion features were reported, but mainly at the platform risers/spools or at the onshore section for the export pipeline. To account for some internal wall loss since their last inspections, these three pipelines are assumed to have lost 10% of their wall thickness by 2022.

The other KH pipelines are not piggable and their estimated wall loss is based on their service and the predicted corrosion rates as stated in the RBI document.

The 12-inch SWK pipelines from the field to KB operated in both directions, carrying dry gas for injection and wet withdrawal gas for process and export. Gas storage in the SWK field ceased in September 2016. The 12-inch SWK pipelines operated in full time wet gas operation until CoP. To estimate the wall thickness loss during services, these lines are assumed to have solely transported dry gas as this leads to a lower wall loss, hence the longest time to complete degradation. By analogy with the 24-in dry gas pipeline, a 10% wall thickness loss during operations is assumed.

The pipelines from Ballycotton and Greensands transported wet gas. Based on the RBI document, an internal corrosion rate of 0.14 mm/year is taken to calculate the wall thickness loss during operations. Note that the Ballycotton pipeline produced until 2018, and was then shut in. A corrosion rate of 0.125 mm/year, the same as for free corrosion in seawater, is taken for the period 2018-2022.

In order to assess the degradation of the KH pipelines, a seawater corrosion rate range of 0.05 to 0.125 mm/year is adopted. This is to account for the long-term general thinning and for some accelerated localised corrosion (e.g. due to bacterial activity) occurring on the pipelines.

Table 3-1 below summarises the estimated remaining wall thicknesses in 2022 and time to complete degradation for the KH pipelines.



PIPELINE	REMAINING WT (MM)	DEGRADATION RATE (MM/YEAR)	TIME RANGE TO COMPLETE DEGRADATION (YEARS)
24-in Gas Export	12.87	0.05 - 0.125	100 - 260
24-in Inter-Platform	12.87	0.05 - 0.125	100 - 260
12-in Inter-Platform	15.75	0.05 - 0.125	120 - 320
12-in SWK Pipeline	12.87	0.05 - 0.125	100 - 260
12-in SWK Extension	12.87	0.05 - 0.125	100 - 260
10-in Greensand	11.64	0.05 - 0.125	90 - 230
10-in Ballycotton	8.42	0.05 - 0.125	70 - 170

Table 3-1 KH Pipeline Degradation

It is stressed that these timescales are approximate and could vary significantly depending on the internal environments within the pipelines and if marine growth, calcareous deposits or bacterial activity can develop.

3.2 Umbilicals

3.2.1 Umbilical Degradation

The umbilicals in the Kinsale area are likely to degrade very slowly over a timescale of hundreds of years. The umbilicals are predominantly buried or covered with rock and concrete, and therefore protected from interaction from fishing gear, sand suspended in the water column and any UV light that penetrates the water column. Water column temperatures are very stable offshore (ranging between 8 to 10°C annually) with nearshore temperatures ranging from 8 to 18°C annually, thus thermal cycling of the umbilicals is limited.

As a result of these benign environmental conditions the breakdown of the plastic in the umbilicals and the leaching of any chemicals or release of microplastics from them is predicted to be very slow and it is unlikely any discernible effect on the benthic or pelagic environments will be evident in future because of the decommissioning *in situ* of these umbilicals. As the degradation of the outer plastic rovings must occur before the bitumen and steel armouring is fully exposed to seawater the degradation of the outer plastic will determine the time required for the initial degradation to occur. Once the outer plastic layer has degraded the degradation of the bitumen / steel armouring layer will begin; there is likely to be a further long period before the internal plastic of the umbilical degrades. This final phase will also encompass the degradation of the copper once the outer plastic sheath on the conductors has broken down sufficiently to allow seawater to access the copper wire. This slow rate of degradation reflects the selection of the various plastics to form the umbilical and provide a reliable permanent engineering solution for the distribution of chemicals and electricity subsea.



Umbilical Component	Time Range to Complete Degradation (years)
Plastics	100 – 200
Metals	50 - 130
Bitumen	100 – 200
Cumulative degradation	250 – 530 ^{Note 1}
Chemical products	Dispersal into seawater

Table 3-2 KH Umbilical Degradation

Notes:

1. Due to the layered construction of the umbilicals, the materials will degrade in a sequence from outside to in, with the plastic rovings first, followed by bitumen base and armour wires. Cumulative degradation is provided to give an indication of total duration to complete degradation.



4 SEVEN HEADS

4.1 Pipelines

4.1.1 Pipeline Degradation

Based on the same approach as detailed in Section 3.1, the wall thickness loss to date and estimated time to complete degradation are summarised in Table 4-1. The internal corrosion rates during operations of the Seven Heads pipelines are taken as 0.04 mm/year.

Pipeline	Remaining WT (mm)	Degradation Rate (mm/year)	Time Range to Complete Degradation (years)
Seven Heads export pipeline	15.32	0.05 - 0.125	120 - 300
Seven Heads well 48/24-5A pipeline	12.02	0.05 - 0.125	90 - 240
Seven Heads well 48/24-6 pipeline	12.02	0.05 - 0.125	90 - 240
Seven Heads well 48/24-8 pipeline	12.02	0.05 - 0.125	90 - 240
Seven Heads well 48/24-9 pipeline	12.02	0.05 - 0.125	90 - 240
Seven Heads well 48/23-2 (abandoned) pipeline	12.02	0.05 - 0.125	90 - 240

Table 4-1 Seven Heads Pipelines Degradation

4.2 Umbilicals

4.2.1 Umbilical Degradation

The umbilicals in the Seven Heads area are likely to degrade very slowly over a timescale of hundreds of years. The umbilicals are surface laid and predominantly covered with the rock and concrete used for pipeline protection, and therefore protected from interaction from fishing gear, sand suspended in the water column and any UV light that penetrates the water column. Water column temperatures are very stable offshore (ranging between 8 to 10°C annually) with nearshore temperatures ranging from 8 to 18°C annually, thus thermal cycling of the umbilicals is limited. Whilst these umbilicals are newer than the Kinsale Area umbilicals they contain a similar range of components many of which are polymeric plastic materials.

As a result of these benign environmental conditions the breakdown of the plastic in the umbilicals and the leaching of any chemicals or release of microplastics from them is predicted to be very slow and it is unlikely any discernible effect on the benthic or pelagic environments will be evident in future because of the decommissioning *in situ* of these umbilicals. As the degradation of the outer plastic rovings must occur before the bitumen and steel armouring



is fully exposed to seawater the degradation of the outer plastic will determine the time required for the initial degradation to occur. Once the outer plastic layer has degraded the degradation of the bitumen / steel armouring layer will begin; there is likely to be a further long period before the internal plastic of the umbilical degrades. This final phase will also encompass the degradation of the copper once the outer plastic sheath on the conductors has broken down sufficiently to allow seawater to access the copper wire. This slow rate of degradation reflects the selection of the various plastics to form the umbilical and provide a reliable permanent engineering solution for the distribution of chemicals and electricity subsea.

Umbilical Component	Time Range to Complete Degradation (years)
Plastics	100 – 200
Metals	50 - 130
Bitumen	100 – 200
Cumulative degradation	250 – 530 ^{Note 1}
Chemical products	Dispersal into seawater

Table 4-2 Seven Heads Umbilical Degradation

Notes:

1. Due to the layered construction of the umbilicals, the materials will degrade in a sequence from outside to in, with the plastic rovings first, followed by bitumen base and armour wires. Cumulative degradation is provided to give an indication of total duration to complete degradation.



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APPENDIX A - PIPELINES AND UMBILICAL DETAILS

A.1 Kinsale Head

PIPELINE	LOCATION	SERVICE	GRADE	OD (MM)	WT (MM)	LENGTH (KM)	EXTERNAL COATING	YEAR INSTALLED	BURIAL STATUS
24-in Export pipeline	KA to shore	Dry gas	X60	609.6	14.3 ¹	54.37	4mm CTE + 25-75 mm CWC	1977	Surface laid, partially buried with some sections of rock dump
24-in Inter-Platform	KA to KB	Wet gas	X52	609.6	14.3	4.96	4mm CTE + 44mm CWC	1977	Surface laid, some rock dump
12-in Inter-Platform	KA to KB	Dry gas	X52	323.9	17.5	5.11	3LPP coating	2001	Fully exposed
12-in SWK Pipeline	KB to SWK	Dry gas	X52	323.9	14.3	6.96	3LPP coating	1999	Partially trenched and extensively rock dumped
12-in SWK Extension	SWK to WDC	Dry gas	X52	323.9	14.3	1.16	3LPP coating	2001	Fully rock dumped
10-in Greensand pipeline	KB to GS	Wet gas	X52	273.1	14.3	7.02	3LPP coating	2003	Fully rock dumped
10-in Ballycotton pipeline	KB to BC	Wet gas	X52	273.1	12.7	12.69	0.5mm FBE coating	1991	Partially trenched, with extensive concrete mattresses

Table A.1 1 KH Pipeline Details

¹ Several wall thickness along the pipeline route – lowest is 14.3mm



UMBILICAL	LOCATION	SERVICE	OD (MM)	LENGTH (KM)	YEAR INSTALLED	BURIAL STATUS
Southwest Kinsale umbilical	KB to SWK	Power / Controls	82	6.96	1999	Partially trenched.
Western drill centre umbilical	WDC to SWK	Power / Controls	82	1.16	2001	Rock dumped for majority of length, some mattresses
Ballycotton umbilical	KB to BC	Power / Controls	98.2	13.00	1991	Trenched, some mattresses

Table A.1 2 KH Umbilical Details



COMPONENTS	MATERIAL
Hoses:	
Hose liner	Hytrell 6356 or Polyamid 11 Besno P40TL
Inner braid	Aramid 1670 D/TEX Kevlar or Aramid 3300 D/TEX Kevlar
Outer braid	Polyester 1220 Dacron T73 or Aramid 1670 D/TEX Kevlar or Aramid 3300 D/TEX Kevlar
Hose cover	Hytrell 6356 or Polyamid 11 Besno P40TL
Cables:	
Electrical core	Copper
Insulation	Ethylene propylene rubber Grade MR1 800
Inner sheath	Ethylene propylene rubber Grade MR3 814
Screen	Copper Tape
Outer sheath	High density polyethylene Grade MTG 974 SN
Fillers	Polyvinylchloride Fillers REF: MPS/01/27 Polypropylene filler
Armouring	Bitumen bedding 3.15mm steel armour wires Black Synthetic Rubber (ethylene propylene diene monomer rubber) High tenacity Polyester Tyre Cord Binding Tape

Table A.1 3 Ballycotton Umbilical Materials



COMPONENTS	MATERIAL
Hoses:	
Hose liner	Polyamid 11
Inner braid	Aramid 1670 D/TEX Kevlar
Outer braid	Aramid 1670 D/TEX Kevlar
Hose cover	Hytrel 6356
Cables:	
Electrical core	Copper wire R10.
Insulation	Ethylene propylene rubber grade MR1 800
Inner sheath	Ethylene propylene rubber grade MR3 814
Screen	Copper tape
Outer sheath	High density polyethylene grade MTG 974 SN
Fillers	polyvinylchloride fillers REF: MPS/01/27 Polypropylene
Armouring	Bitumen bedding 3.15mm steel armour wires Black synthetic rubber (ethylene propylene diene monomer rubber) High tenacity polyester tyre cord Binding tape

Table A.1 4 Southwest Kinsale Umbilical Materials



A.2 Seven Heads

Pipeline	Location	Service	Grade	OD (mm)	WT (mm)	Length (km)	External Coating	Year Installed	Burial Status
Seven Heads export pipeline	Manifold to KA	Wet gas	X52	457.2	16	35.00	3LPP coating + CWC	2003	Partially trenched with extensive rock dump
Seven Heads well 48/24-5A pipeline	Well A to Manifold	Wet gas	X52	219.1	12.7	1.57	3LPP coating	2003	Buried along its entire length
Seven Heads well 48/24-6 pipeline	Well B to Manifold	Wet gas	X52	219.1	12.7	4.67	3LPP coating	2003	Buried along its entire length
Seven Heads well 48/24-8 pipeline	Well D to Manifold	Wet gas	X52	219.1	12.7	6.32	3LPP coating	2003	Buried along its entire length
Seven Heads well 48/24-9 pipeline	Well E to Manifold	Wet gas	X52	219.1	12.7	5.77	3LPP coating	2003	Buried along its entire length
Seven Heads well 48/23-2 (abandoned) pipeline	Well F to Manifold	Wet gas	X52	219.1	12.7	7.45	3LPP coating	2003	Buried along its entire length

Table A.2 1 Seven Heads Pipelines Details



UMBILICAL	LOCATION	SERVICE	OD (MM)	LENGTH (KM)	YEAR INSTALLED	BURIAL STATUS
Seven Heads Main	KA to Manifold	Power / Controls	123.5	35.00	2003	Laid alongside pipeline sharing protection materials
Seven Heads In-field (5 off)	Manifold to Wells	Power / Controls	93.2	25.78	2003	Laid alongside pipeline sharing protection materials

Table A.2 2 Seven Heads Umbilical Details

COMPONENTS	MATERIAL
Hoses:	
Hose liner	Finathene 3802 YCF
Inner braid	Kevlar T925
Outer braid	Kevlar T925
Hose cover	Finathene 3802 B
Cables:	
Electrical core	Copper wire.
Insulation	Low Density Polyethylene
Inner sheath	Polyvinyl Chloride
Screen	Copper tape
Outer sheath	High density Polyethylene
Fillers	Polyvinylchloride, Polypropylene
Armouring	Bitumen bedding, galvanised steel armour wires poly propylene roving, binding tape

Table A.2 3 Seven Heads Umbilical Materials